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7.19.05

OPTICAL DISC APPARATUS

This application is a REI of 09/660,766 [illegible] PAT 6400663

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical disk apparatus for optically reproducing/recording a signal from/to an information medium (e.g., an optical disc) using a light beam from a light source such as a semiconductor laser. More particularly, the present invention relates to an optical disc apparatus which performs a focus servo.

2. Description of the Related Art

In order to optically reproduce/record information from/to an information medium using a light beam from a light source such as a laser, it is necessary to perform a focus servo so that the focal point (converging point) of the laser beam always stays on the information surface of the information medium. In order to achieve this, an operation called a focus pull-in is performed. That is to move an object lens, prior to the focus servo, so that the focal point of the laser beam is brought to the information surface of the information medium.

According to a conventional method such as described in Japanese Laid-open Publication No. 62-33340, if the focus pull-in fails, the rotation and the phase of the disc is shifted and the focus pull-in is attempted again. FIG. 20 shows an optical disc apparatus performing the focus servo by a focus pull-in in such a manner.

The optical disc apparatus in FIG. 20 includes an optical system for irradiating a light beam on a disc 101 (i.e., an information medium) and forming a light beam spot 111 thereon. The optical system includes a light source 103, e.g., a semiconductor laser, for generating a light beam 110 and a converging lens 107. The optical disc apparatus further includes a disc motor 102 for rotating the disc at a predetermined number of revolutions. The light beam 110 emitted from the light source 103 is converged by the converging lens 107, whereby the light beam spot 111 is formed on the information surface of the disc 101. A focus actuator moves the converging lens 107 in a direction perpendicular to the disc surface, thereby changing the position of the focal point of the light beam. The reflecting light from the light beam spot 111 on the disc 101 passes through the converging lens 107 and then enters a 4-region photodetector 109.

The 4-region photodetector 109 is divided into four regions A to D. The signals detected by the diagonally positioned regions are added together by an adder 121, whereby summation signals are created. Specifically, the signals detected by the regions A and D are added to create a summation signal A+D, and the signals detected by the regions B and C are added to create a summation signal B+C. The summation signal B+C is then subtracted from the summation signal A+D, whereby a differential signal is created. A focus error signal FE is created from the differential signal by using an astigmatic method in which the differential signal is smoothed by a low pass filter (LPF) 123. The focus error signal FE is input to a digital signal processor (DSP) 125, and then through filter calculation such as adding, multiplying, shift processing by a focus servo control section 125*a*, a drive signal FOD is created and output from the DSP 125. The current of the drive signal FOD is amplified by a focus driving circuit 126, thereby driving a focus actuator 127. Accordingly, the focus servo is achieved.

During a reproducing/recording of the information, the optical disc not only rotates but also moves up and down in a direction perpendicular to the information surface of the disc, i.e., axial deviation occurs. Referring to FIG. 21, the problem of the focus pull-in will now be described in the case where the axial deviation is significant. FIG. 21 shows the relationship between the focal point of the light beam and the position of the information surface on the disc.

As shown in FIG. 21, in the case where the relative speed of the information surface of the disc to the focal point is great due to the axial deviation during a high-speed rotation of the disc, the focus servo can not follow the axially deviating motion of the disc and therefore the focus pull-in fails. As a result, the focus servo is not achieved. In order to solve this problem, in the conventional example shown in FIG. 20, the rotation phase of the disc is detected using a rotation phase detector 112 and the focus pull-in section 125*b* in the DSP 125 repeatedly conducts the focus pull-in attempt by changing the movement of the focal point of the converging lens, as shown by a through d in FIG. 21. Based on the detected rotation phase of the disc, the focus pull-in is repeated. When the rotation phase of the lens comes to the point where the relative speed of the information surface of the disc to the focal point becomes minimum, the focus servo is achieved.

When a disc is rotated for high-speed reproduction, the acceleration of eccentricity and the acceleration of axial deviation of the optical disk increase in proportion to the square of the rotation speed of the disc. In order to follow this acceleration of the axial deviation, the gain crossover point of the servo system and the thrust of the actuator are increased according to the conventional method. However, a significant axial deviation of the disc reduces the range of the disc rotation phase in which the speed of the axial deviation is at or below the level at which a successful focus pull-in is possible. Therefore, it is necessary to change the focus point of the light beam by small steps. This reduces the possibility of obtaining the rotation phase in which a successful focus pull-in is possible. As a result, the number of focus pull-in attempts increases and thus it takes longer before a successful focus pull-in.

SUMMARY OF THE INVENTION

According to one aspect of this invention, there is provided an optical disc apparatus including: a converging section for converging a light beam and irradiating a rotating information medium with the converged light beam; a moving section for moving the converging section, thereby moving a converging point of the converged light beam in a direction perpendicular to an information surface of the information medium; a converging state detection section for generating a focus servo signal which represents a converging state of the light beam on the information medium based on reflected light or transmitted light of the light beam from the information medium; a focus servo control section for controlling the moving section based on the focus servo signal, so that the light beam reaches a predetermined converging state on the information medium; and a focus pull-in section for turning ON the control by the focus servo control section, wherein the focus pull-in section turns ON the control by the focus servo control section in a case where the focus pull-in section determines that the converging point of the light beam is located in the vicinity of the minimum velocity position on the information medium axial deviation.

In one embodiment of the invention, the optical disc apparatus further includes an S-shape signal detection section for detecting S-shape signals which appear in the focus